# WOODLOT MANAGEMENT
# HOME STUDY COURSE

## MODULE 1
## INTRODUCTION TO SILVICULTURE

Canada

Nova Scotia

100-06011/

## FOREWORD

This Woodlot Management Home Study Course Series is an educational approach designed to help the woodlot owners understand integrated resource management.

This series is intended to help you understand the concepts of good forest management as they apply to your woodlot. Because forest management is such a broad topic, this series is divided into several study modules. These modules cover many aspects of forest resource management, including silviculture, harvesting, spacing, regeneration, wood utilization, wildlife management, forest ecology, and recreation. They are designed to be read easily and studied at home. At the end of each chapter is a self-answer quiz. It is important to complete each quiz as your answers will indicate whether you have understood the chapter. After a module is studied at home, field days will be arranged to review the material and show how it applies to woodlot situations.

The intent is to develop modules that review all woodlot management activities, including woodlot road and fire pond construction, boundary line maintenance and survey, woodlot equipment, and woodlot finances.

'Introduction to Silviculture' is a building block for some of the other modules. After it explains the importance of forestry, it reviews the basic characteristics of trees, and stand growth and development information essential to understanding forest management activities.

Some things you can learn from the Woodlot Management Home Study Course modules and the field days are:

(1) The silvic characteristics of the common native softwood and hardwood trees of Nova Scotia;

(2) The major factors that affect stand growth and development;

(3) The use of silvic and growth information and the silviculture techniques to increase the productivity and quality of your woodlot stands;

(4) How these forest management activities, combined with patience and commitment, will increase the long-term value of your woodlot;

(5) How to incorporate all aspects of integrated resource management to develop the tremendous potential of your woodlot.

"Introduction to Silviculture" was originally produced as a co-operative effort between the Canadian Forestry Service and the Department of Lands and Forests in 1987 and has been updated in 1994. The original text was written by LaHave Forestry Consultants Ltd. with editorial help from Lands and Forest and Canadian Forestry Service staff.

We sincerely hope that you enjoy and benefit from the material presented.

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## LESSON 1

## INTRODUCTION

### IMPORTANCE OF OUR FORESTS AND THE FOREST INDUSTRY

Diverse, healthy forests are vital to the well being of our planet. Forests are complex, living systems that are home to a variety of organisms. They protect our soils, rivers and our lakes where fish live. They are also a valuable recreational resource. Even the quality of the air we breathe depends, to a great extent, on forests. Trees store carbon and absorb carbon dioxide (especially fast growing ones), thereby reducing the greenhouse effect.

Economically, the forest industry is vital to Canada and Nova Scotia. Nationally, in 1989, the industry contributed $20 billion (almost 4%) to the gross domestic product; almost $23 billion (17%) to our exports (Figure 1); and almost $20 billion to our balance of trade (more than agriculture, fishing, mining, and energy combined) in 1989.

Provincially, in 1989, forestry contributed $473 million (3%) to our gross domestic product; more than $500 million (24%) in exports; and almost $500 million to our balance of trade. Almost 7,000 direct and 5000 indirect jobs result from the forest industry in Nova Scotia, 3 percent of the employed labour force (Forestry Facts, 1990).

To maintain this provincial industry, approximately 4 million cubic metres (1.7 million cords) of roundwood is harvested each year. More than half of this wood comes from small private woodlots that make up 48 percent of the forested land base in Nova Scotia. The land is owned by 32,000 small landowners who own less than 400 hectares (1,000 acres) each.

The forest has provided Nova Scotians with a way of life for many generations. If we are to maintain a healthy productive forest in the future, it is important that everyone understand the forest and practice sustainable forest management.

Understanding trees and how they grow is basic to the practice of silviculture, which is used to manage the forest to meet a specified objective. Silviculture is the practice by which stands are tended, harvested and replaced by new stands. It includes the "green circle" from plantations/natural regeneration to harvesting (Figure 2).

The intent of this "Introduction to Silviculture" is to help readers understand some basic characteristics of tree species which can be applied through silviculture. It does not discuss silvicultural techniques, or the related subject of forest ecology; these are dealt with in later modules.

## NET CONTRIBUTION OF EXPORT DOLLARS (1989)
## (IN MILLIONS OF DOLLARS)
## Source: Forestry Facts 1990

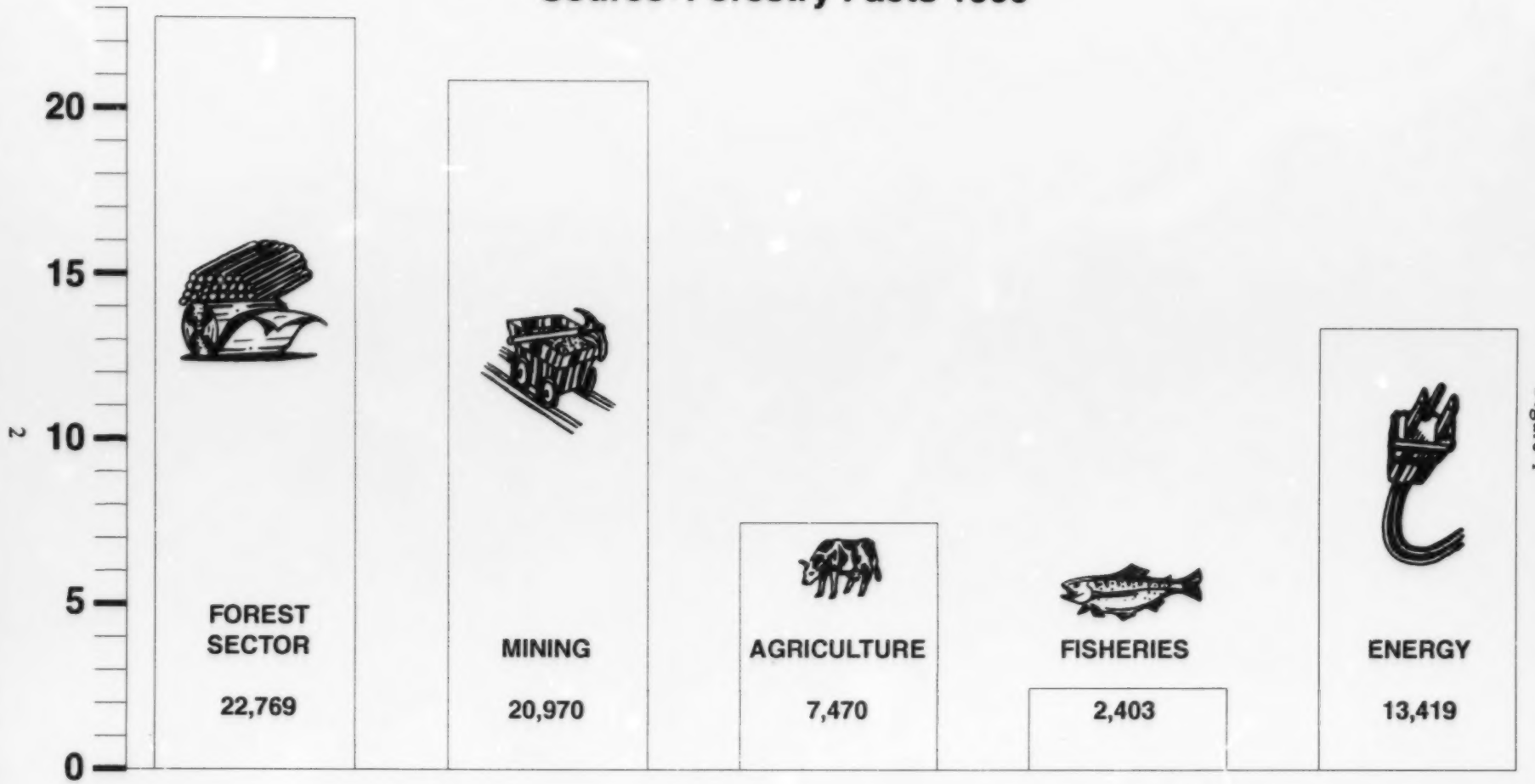



Figure 1

**In no other Canadian Industry do exports so greatly exceed imports. The surplus of 19.5 billion is more than other natural resources surpluses combined.**

Figure 2

# SILVICULTURE CYCLE

## THE SETTLER'S FOREST

Try to imagine you are an early settler arriving for the first time in the New World. You are greeted by a seemingly endless forest of pine, spruce and hemlock, as well as majestic hardwoods. While today we may yearn for this sight, to the early settlers the forest was an enemy that had to be conquered if they were to survive.

The same forest that initially presented an obstacle to the survival and success of the new settlers soon became a source of wealth. The best white pine trees were cut and exported to supply the world shipbuilding industry. Later, the demand for spruce and hemlock lumber fed both the local and export markets. When the supply of sawlogs dwindled, pulp mills were established and areas previously cut for sawlogs were recut. Each time the forest was cut, only the biggest and best trees were taken. The attitude of most people at that time was that the supply of wood was endless. It didn't take long before the forests of Nova Scotia consisted of poor quality trees. A study conducted by Fernow (a noted forester) in 1909-1910 concluded that the forest was:

> "largely in poor condition, and is being annually further deteriorated by abuse and injudicious use because those owning it are mostly not concerned in its future and do not realize its potentialities".

High-grading, which removed the very best trees, was common practice. In many cases, only the poor quality trees were left. Since these trees were the main seed source, they produced poor quality, sparse stands of low volume.

Clearcutting began with the introduction of mechanical logging equipment. While it is an appropriate harvesting system in some forests, clearcutting was often not done properly and has produced some poor quality forests. It removed all merchantable trees from an area at the same time. Large clearcuts tend to regenerate with pioneer species that cannot tolerate shade (such as trembling aspen, pin cherry, and red maple).

Forest fire also contributed to the general degradation of the forest. During the early 1900's, fire was used to clear land. These fires spread into the surrounding forest and destroyed thousands of acres of wood and in some severe cases, damaged the soil. A fire prevention and suppression program began in 1927 when the damage these fires caused was realized. Insects and diseases have also adversely affected the quality of our forests.

## THE FORESTS OF TODAY

Past forestry practices in Nova Scotia have degraded the content and quality of today's forests which are comprised of 45% softwood stands, 25% mixedwood stands, and 30% hardwood stands. Figure 3 shows the major tree species in Nova Scotia and their abundance in our forests.

The total gross merchantable volume for all species in Nova Scotia is 250 million cubic metres (104 million cords). Sixty-one percent (61%) is softwood (152 million cubic metres or 63 million cords) and 39% is hardwood (97 million cubic metres or 40 million cords). (N.S. Provincial Forest Inventory, 1991).

Although today's forests produce an average of 3 cubic metres per hectare per year (0.3 cords per acre per year), intensive management on productive soils can increase the growth to an estimated 13 $m^3$/ha/yr. (1.5 cd/ac/yr.).

With approximately 73% of the productive forested land in private ownership, public awareness of silviculture's importance is vital to the management of woodlots for wood products, as well as for wildlife and recreation.

Woodlots were not properly managed in the past bacause settlers lacked the knowledge; there were few established guidelines, and there was limited revenue. Many operators were simply unaware of the long-term effects of high-grading. Minimal returns on stumpage does not encourage reinvestment in the forest, and legislative guidelines for harvesting methods were not enforced. Indiscriminate cutting was indirectly encouraged.

A combination of cash incentives, tax incentives, public education, legislation, and increased revenues for wood are necessary for a well managed forest. Through provincial and federal government programs that assist woodlot owners to manage their forests, attempts are being made to correct past mistakes.

The role of the small private woodlot is becoming increasingly important to the economic health of the forest industry. Due to past practices, we have created a forest that is 41% mature to overmature. Another 35% will be in these age groups within the next 20 years. We face a potential wood shortage in some areas by 2005. With this short fall, demand for wood from small private woodlots will increase.

Because the best land was granted to the public, small private woodlots have a higher net growth rate than those of large landowners or Crown lands. Therefore, silvicultural investment on small private woodlots usually generates a relatively higher return.

Recognizing the value of the small private woodlot owner's contribution to forestry in Nova Scotia, the provincial government in its 1986 Forestry Policy states the following as part of their long term objectives:

> "Encouraging the development and management of private forest lands as the primary source of timber for industry in Nova Scotia" and "Supporting private landowners to make the most productive use of their forest lands".

This forest policy not only recognizes the value of small woodlots to the province's welfare , but also recognizes the importance of the owners' needs. Towards this end, the policy states that the small private woodlot owner will:

> "Have a fair share of the available market for primary forest products and receive a fair and reasonable return for primary forest products sold."
>
> "Continue to enjoy the traditional rights and responsibilities of private ownership of land."
>
> "Continue to receive incentive assistance in managing their lands for forestry purposes."

Without wood from small private woodlots, the forest industry could not survive over the long run and our standard of living and way of life would change.

**THE FUTURE FOREST**

A forest may take 40 to 100 years to mature. Consequently, we must practice sound management to ensure a productive forest industry for our children.

We can no longer afford to cut without regard for the future, have cuts that do not regenerate fully with desirable species, leave poor trees as a seed source, clearcut to the river banks and streams, or disregard the environmental needs of our wildlife.

Proper forestry practices must be the concern of everyone regardless of whether or not they work directly in the forest industry. We have used our forests to build a great nation. Now it is time to use our great nation to rebuild our forests (Figure 3).

# GOOD RESOURCE MANAGEMENT

Figure 3

## QUIZ

**True or False**

_____ 1. Eight percent of Nova Scotia forests are privately owned.

_____ 2. Silviculture is the practice by which stands are tended, harvested and replaced by new stands.

_____ 3. Eastern hemlock was the most sought after species by the world shipbuilding industry in earlier times.

_____ 4. In 1910, Fernow concluded that Nova Scotia forests were largely in good condition.

_____ 5. The forest is a complex living system.

_____ 6. High-grading results in a superior forest.

_____ 7. Today Nova Scotia forest stands are comprised of 45% softwood, 25% mixedwood and 30% hardwood.

_____ 8. Through silviculture, we can increase forest productivity approximately fourfold.

_____ 9. Canada has an abundant wood supply and hence we can cut with no concern for the future.

_____ 10. In Nova Scotia, most of our forests grow to maturity and can be harvested within 30 years.

## LESSON TWO

## SOFTWOOD TREE IDENTIFICATION AND SILVICS

The first step in the study of silviculture is to recognize trees common to Nova Scotia. The Department of Natural Resources' publication "Trees of Nova Scotia" identifies the main trees in our province. In addition, there are some "rules of thumb" that will help you identify trees.

Once a tree is identified it is helpful to understand its rooting habit, windfirmness, associated species, favored growing sites and shade tolerance. Shade tolerance refers to a tree's ability to survive and grow in shaded conditions.

This lesson presents these silviculture and field identification characteristics of softwood trees in Nova Scotia (Figure 4).

Where possible, technical forestry terms have been avoided, although in some cases their use is necessary for clarity. A glossary at the end of the module defines unfamiliar forestry terms. The section entitled "Average Mature Tree" has been included as a rough guide to help with identification. An average tree does not exist.

Figure 4

# SOFTWOOD SILHOUETTES

WHITE PINE

JACK PINE

RED PINE

TAMARACK

RED SPRUCE

WHITE SPRUCE

BLACK SPRUCE

HEMLOCK

BALSAM FIR

## SILVICS OF RED SPRUCE

| | | |
|---|---|---|
| Species: | - | red spruce (Picea rubens Sarg.) |
| Common names: | - | yellow spruce, maritime spruce |
| Field identification aids: | - | reddish bark on young trees |
| | - | orange and slightly hairy twigs |
| | - | shiny, bright yellow-green needles |
| | - | the ends of the branches tend to curve upward |
| | - | red and black spruce interbreed and are often difficult to tell apart |
| Average mature tree: | - | 80 to 100 years old |
| | - | 21 m to 24 m (70' to 80') tall |
| | - | 30 cm to 60 cm (12" to 24") diameter at 1.3 m (4.5') from the ground |
| Tolerance: | - | very tolerant |
| Rooting: | - | shallow and widespreading |
| Reproduction: | - | reproduces by seed |
| | - | tree may begin to produce seed when 20 to 30 years old, with full crop production usually after 45 years |
| | - | good cone crops every 3 to 8 years |
| | - | best seed germination occurs on a moist mixture of mineral soil and humus |
| | - | poor germination on thick duff |
| Growing sites: | - | range from well drained to poorly drained |
| | - | best growth is on well drained, acid sandy soil |
| | - | usually found on moderately drained soils |
| Associated species: | - | black spruce, balsam fir, tamarack, and red maple on poorly drained sites |
| | - | sugar maple, yellow birch, beech and balsam fir on well drained sites |
| | - | often found in pure stands |
| Windfirmness: | - | only moderately windfirm on most Nova Scotia sites |

Principal enemies:

- spruce budworm, eastern spruce bark beetle, dwarf mistletoe, balsam fir sawfly, porcupines

Notes:

- red spruce and black spruce comprise 27.5% of merchantable volume of our forests
- the most valuable lumber and pulpwood species in Nova Scotia
- Nova Scotia's provincial tree

## SILVICS OF WHITE SPRUCE

| | | |
|---|---|---|
| Species: | - | white spruce (Picea glauca (Moench) Voss). |
| Common names: | - | cat spruce, pasture spruce, skunk spruce |
| Field identification aids: | - | occurs commonly in old fields |
| | - | has thick limbs that extend to ground |
| | - | inside bark is silvery white |
| | - | crushed needles have odour similar to cat urine |
| Average mature tree: | - | 50 to 60 years old |
| | - | 18 m to 24 m (70' to 80') tall |
| | - | 30 cm to 60 cm (12" to 24") in diameter |
| Tolerance: | - | intolerant |
| Rooting: | - | shallow and widespreading |
| Reproduction: | - | reproduce by seed |
| | - | tree may begin to produce seed when approximately 30 years old, with full production around 60 years |
| | - | good seed crop production every 2 to 6 years |
| | - | best seed germination occurs on well to moderately drained soil |
| Growing sites: | - | range from well drained to moderately drained soils |
| | - | optimum growth is on moist, well drained sandy soils |
| | - | usually found in on moderately drained sandy loams |
| Associated species: | - | black spruce and balsam fir on poorly drained sites |
| | - | white birch and trembling aspen on well drained sites |
| Windfirmness: | - | moderately windfirm on most Nova Scotia sites |

| | | |
|---|---|---|
| Principal enemies: | - | spruce budworm, eastern spruce bark beetle, eastern spruce sawfly, and porcupines |
| Notes: | - | comprises 7.9% of merchantable Nova Scotia forests |
| | - | commonly found on old pasture land and has thick live branches that extend to the ground |
| | - | fastest growing spruce native to Nova Scotia |

## SILVICS OF BLACK SPRUCE

| | | |
|---|---|---|
| Species: | - | black spruce (Picea mariana (Mill.) BSP) |
| Common names: | - | bog spruce, swamp spruce, red spruce |
| Field identification aids: | - | usually the only spruce growing in bogs and swamps |
| | - | inner bark is olive green |
| | - | retains cones for many years |
| | - | forms a definite clump of branches at tip of crown |
| | - | brownish, hairy twigs; otherwise quite similar to those of red spruce |
| Average mature tree: | - | 70 to 90 years old |
| | - | 9 m to 15 m (30' to 50') tall |
| | - | 15 cm to 25 cm (6" to 10") in diameter at 1.3 m (4.5') from the ground |
| Tolerance: | - | medium |
| Rooting: | - | shallow, spreading root system |
| Reproduction: | - | can reproduce through seed or by layering (wetter sites) |
| | - | heavy cone crops every 4 years |
| Growing sites: | - | ranges from wet to well drained sites |
| | - | best growth is on moist, well drained loamy soils |
| | - | usually grows on poorly drained soils |
| Associated species: | - | white spruce and balsam fir on good sites |
| | - | on poor sites usually grows in pure stands or associated with larch |
| Windfirmness: | - | shallow rooted and easily blown over |

Principal enemies:

- porcupine and balsam fir sawfly which causes moderate damage
- due to late bud development, usually escapes major spruce budworm defoliation

Notes:

- with red spruce, it comprises 27.5% of merchantable volume of Nova Scotia forests
- interbreeds easily with red spruce and at times they are difficult to tell apart
- has sealed cones that require heat to open
- first conifer to establish after a fire

## SILVICS OF BALSAM FIR

| | | |
|---|---|---|
| Species: | - | balsam fir (Abies balsamea (L.) Mill.) |
| Common names: | - | fir, balsam |
| Field identification aids: | - | only native softwood with resin blisters on the bark that exude a sticky resin |
| | - | typical Christmas tree smell (balsam) |
| | - | needle does not roll easily between fingers |
| | - | tip of needles are blunt (spruce are sharp) |
| | - | needles are dark, shiny green above with two white lines underneath |
| | - | only native conifer with upright cones |
| Average mature tree: | - | 40 to 50 years old |
| | - | 12 m to 18 m (40' to 60') tall |
| | - | 20 cm to 36 cm (8' to 14') diameter at 1.3 m (4.5') from the ground |
| Tolerance: | - | very tolerant |
| Rooting: | - | shallow, widespreading roots |
| Reproduction: | - | reproduces by seed |
| | - | tree may begin to produce seed as early as 15 years old with full crop production after 30 years |
| | - | good crops can be expected every 2 to 4 years |
| | - | best seed germination occurs on moist mineral soils or humus |
| Growing sites: | - | adaptable to a variety of soils |
| | - | best growth on moist, well drained loams |
| Associated species: | - | forms pure stands on poorly drained sites |
| | - | grows in association with almost all native trees |
| Windfirmness: | - | not windfirm |

| | | |
|---|---|---|
| Principal enemies: | - | spruce budworm, balsam woolly aphid, porcupines |
| | - | butt rot caused by fungal attack |
| Notes: | - | comprises 17.9% of merchantable volume of Nova Scotia forests |
| | - | principal Christmas tree species |
| | - | after about 40 years old, fir tends to develop butt rot that reduces its value as pulpwood |

## SILVICS OF WHITE PINE

| | | |
|---|---|---|
| Species: | - | eastern white pine (Pinus strobus L.) |
| Common names: | - | eastern white pine, soft pine, pattern pine, yellow pine, majestic pine |
| Field identification aids: | - | only native five-needled pine |
| | - | needles are soft to the touch |
| | - | cigar shaped cones that are longer than those of other native pines |
| Average mature tree: | - | 100 to 120 years |
| | - | 24 m to 30 m (80' to 100') tall |
| | - | 60 cm to 90 cm (24" to 36") diameter at 1.3 m (4.5') from ground |
| Tolerance: | - | medium |
| Rooting: | - | moderately deep, widespreading root system |
| | - | will produce a token tap root where soil permits |
| Reproduction: | - | reproduces by seeding |
| | - | may produce seed as young as 20 with full crop production at 50 years |
| | - | good seed crop production every 3 to 5 years |
| | - | best germination occurs on exposed moist sandy loam |
| | - | litter is a poor seed bed |
| Growing sites: | - | range from dry rocky sites to poorly drained sites |
| | - | best growth is on moist, loamy sands |
| Associated species: | - | on poorly drained soils with black spruce and larch |
| | - | jack pine and red pine on dry sites |
| | - | hemlock, red spruce, yellow birch and sugar maple on well drained sites |
| Windfirmness: | - | moderately windfirm |

Principal enemies: - white pine blister rust, white pine weevil

Notes:
- comprises 4.5% of merchantable volume of Nova Scotia forests
- many of the large trees standing above the rest in the forest are residual white pine
- the tallest and most stately of the eastern softwoods
- highly prized for interior finish
- straight grained, even textured, durable, light weight wood that takes nails, planing and painting well

## SILVICS OF RED PINE

| | | |
|---|---|---|
| Species: | - | red pine (Pinus resinosa Ait.) |
| Common names: | - | Norway pine, bull pine |
| Field identification aids: | - | has the longest needles of pines with two needles per cluster |
| | - | needles break in two when bent |
| | - | bark is platy and distinctly red |
| Average mature tree: | - | 60 to 70 years old |
| | - | 18 m to 24 m (60' to 80') tall |
| | - | 30 cm to 60 cm (12" to 24") diameter at 1.3 m (4.5') from the ground |
| Tolerance: | - | intolerant |
| Rooting: | - | moderately deep and widespreading |
| Reproduction: | - | reproduces by seed |
| | - | tree may begin to produce seed at 20 with full production after 50 years |
| | - | good seed crop produced every 3 to 7 years, with a bumper crop every 10 to 12 years |
| | - | germination best on moist humus mineral mixture |
| | - | poor germination on heavy litter |
| Growing sites: | - | will grow on soils too poor for white pine |
| | - | best growth is on well drained sandy soils |
| Associated species: | - | white pine and jack pine |
| | - | occasionally grows in pure stands |
| Windfirmness: | - | moderate to good depending on soil depth |

| | | |
|---|---|---|
| Principal enemies: | - | Sirococcus shoot blight, European pine shoot moth, white pine weevil, pine root collar weevil |
| | - | prone to mechanical breakage |
| Notes: | - | with larch, comprises less than 1.4% of merchantable volume of Nova Scotia forests |
| | - | sturdy rot resistant wood makes it ideal for power poles and wharf and bridge pilings |

## SILVICS OF JACK PINE

| | | |
|---|---|---|
| Species: | - | jack pine (Pinus banksiana Lamb.) |
| Common names: | - | princess pine, scrub pine, grey pine |
| Field identification aids: | - | cones point toward end of branch |
| | - | cones are strongly curved |
| | - | retains cones for years, even after tree is cut |
| | - | dead branches remain on tree giving it a scraggy appearance |
| | - | needles are light yellow-green |
| | - | needles two per cluster forming a "V" |
| Average mature tree: | - | 50 to 60 years old |
| | - | 12 m to 18 m (40' to 60') tall |
| | - | 20 cm to 30 cm (8" to 12") diameter at 1.3 m (4.5') from ground |
| Tolerance: | - | intolerant |
| Rooting: | - | moderately deep and widespreading |
| | - | produces a tap root on deep porous soils |
| Reproduction: | - | reproduces by seed |
| | - | will begin to produce seed as early as 10 years with full production at 40 years |
| | - | good cone crop every 3 to 4 years |
| | - | best germination is on moist mineral soil |
| Growing sites: | - | range from dry to poorly drained soils |
| | - | best growth is on sandy, well drained soils |
| Associated species: | - | black spruce, white birch and aspen |
| | - | can be found in pure stands |
| Windfirmness: | - | windfirm, but prone to mechanical breakage |

| | | |
|---|---|---|
| **Principal enemies:** | - | **porcupines** |
| **Notes:** | - | **comprises less than 1% of merchantable volume of Nova Scotia forests** |
| | - | **often establishes after a fire, particularly on poor sites** |

## SILVICS OF EASTERN HEMLOCK

| | | |
|---|---|---|
| Species: | - | eastern hemlock (Tsuga canadensis (L.) Carr.) |
| Common names: | - | tree juniper, white hemlock |
| Field identification aids: | - | bark is purplish-brown when scraped |
| | - | needles are on short stalks, blunt tipped and are dark shiny green with two white lines below |
| Average mature tree: | - | 100 to 140 years old |
| | - | 18 m to 21 m (60' to 70') tall |
| | - | 60 cm to 122 cm (24" to 48") diameter at 1.3 m (4.5') from the ground |
| Tolerance: | - | very tolerant |
| Rooting: | - | widespreading, shallow root system |
| Reproduction: | - | reproduces by seed |
| | - | begins to produce seed as early as 20 with full production after 50 years |
| | - | good cone crop every 2 to 3 years |
| | - | best germination is on a shaded cool site |
| Growing sites: | - | grows on a wide range of soils, as long as is shaded and cool |
| Associated species: | - | white pine, red spruce, yellow birch, sugar maple |
| | - | occasionally occurs in pure stands |
| Windfirmness: | - | moderately windfirm |

| | | |
|---|---|---|
| Principal enemies: | - | hemlock looper, porcupines, and windstorms |
| | - | wind causes cracks between growth rings in larger trees that may increase heart rot |
| Notes: | - | comprises 3.2% of merchantable volume of Nova Scotia forests |
| | - | bark is often riddled with woodpecker holes |

## SILVICS OF TAMARACK

| | | |
|---|---|---|
| Species: | - | tamarack (Larix laricina (Du Roi) K. Koch.) |
| Common names: | - | larch, juniper (not a true juniper), hackmatack |
| Field identification aids: | - | loses needles in autumn |
| | - | has smallest cone of native conifers |
| | - | many needles in a cluster |
| | - | soft, blue-green needles turn yellow in autumn |
| Average mature tree: | - | 50 to 70 years old |
| | - | 12 m to 18 m (40' to 60') tall |
| | - | 30 cm to 60 cm (12" to 24") diameter at 1.3 m (4.5') from ground |
| Tolerance: | - | very intolerant |
| Rooting: | - | shallow and widespreading |
| Reproduction: | - | reproduces by seed |
| | - | occasionally reproduces by layering |
| | - | will bear seed as early as 12 years old with full production after 40 years |
| | - | best germination on moist mineral or organic soil with light cover |
| | - | good cone crop every 3 to 6 years |
| Growing sites: | - | range from upland sites to bogs |
| | - | best growth is on well drained light soils |
| | - | usually found on wet sites |
| Associated species: | - | black spruce and red maple on poor sites |
| | - | on better sites occurs with trembling aspen, white birch and balsam fir |
| Windfirmness: | - | moderately windfirm |

| | | |
|---|---|---|
| Principal enemies: | - | larch sawfly, white-marked tussock moth, porcupines |
| Notes: | - | with red pine, comprises 1.4% of merchantable volume of Nova Scotia forests |
| | - | fastest growing softwood on good sites |
| | - | characteristic tree of swamps and bogs |

"Trees of Nova Scotia" provides a complete list of additional native and introduced softwoods that grow here in insignificant amounts.

## QUIZ

**True or False**

_____ 1. All softwoods are evergreen.

_____ 2. Red spruce is an intolerant tree.

_____ 3. White spruce often occurs in old fields and is very branchy.

_____ 4. Black spruce can reproduce by layering.

_____ 5. Balsam fir needles roll easily between thumb and finger.

_____ 6. White pine, due to its shallow rooting, is not windfirm.

_____ 7. Red pine can grow under heavy shade.

_____ 8. Jack pine often establishes naturally after a fire.

_____ 9. Eastern hemlock is a long-lived tree.

_____ 10. Tamarack is preferred by porcupines.

## LESSON THREE

## HARDWOOD TREE IDENTIFICATION AND SILVICS

This lesson introduces the common hardwoods (Figure 5) of Nova Scotia. Specific identification features can be found in the course reference "Trees of Nova Scotia".

### SILVICS OF SUGAR MAPLE

| | | |
|---|---|---|
| Species: | - | sugar maple (Acer saccharum Marsh.) |
| Common names: | - | rock maple, hard maple |
| Field identification aids: | - | new shoots are light brown or rust coloured while red maple shoots are dark red |
| | - | buds are opposite and sharp pointed (red maple has blunt buds that are much larger). |
| | - | leaf margin between lobes is smooth and curved |
| | - | leaf edge has fewer teeth than red maple leaves |
| | - | graceful branching whereas red maple branching is more irregular |
| Average mature tree: | - | 100 to 120 years old |
| | - | 24 m to 27 m (80' to 90' tall) |
| | - | 30 cm to 60 cm (12" to 24") diameter at 1.3 m (4.5') from ground |
| Tolerance: | - | tolerant |
| Rooting: | - | deep and widespreading |
| Reproduction: | - | reproduces by seed, stump sprouting and to some extent root suckers |
| | - | tree may begin to produce seed when 40 to 60 years old, with full crop production after 70 to 100 years |
| | - | good seed crop production every 2 to 5 years |
| | - | best seed germination occurs on moist, mineral humus mixture |
| | - | has the unique ability to reproduce on undisturbed forest litter |

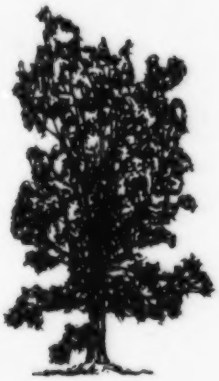
Figure 5

# HARDWOOD SILHOUETTES

SUGAR MAPLE

PIN CHERRY

WHITE BIRCH



BEECH

RED OAK

WHITE ASH

RED MAPLE

YELLOW BIRCH

LARGETOOTH ASPEN

TREMBLING ASPEN

| | | |
|---|---|---|
| Growing sites: | - | range from well drained to dry |
| | - | best growth is on deep fertile, well drained moist loam soil |
| | - | usually found on well drained upland soils |
| Associated species: | - | usually found with beech, yellow birch and red spruce on good sites |
| | - | occasionally found in pure stands |
| Windfirmness: | - | windfirm |
| Principal enemies: | - | spruce budworm and the leaf-browning disease called anthracnose cause local damage |
| Notes: | - | comprises 6.6% of merchantable volume of Nova Scotia forests |
| | - | young shoots are heavily browsed by deer |
| | - | best tree for producing sap for maple sugar |
| | - | wood is excellent for flooring, furniture, interior finishing, veneers, sporting goods, and musical instruments |
| | - | a majestic shade tree |

## SILVICS OF RED MAPLE

| | | |
|---|---|---|
| Species: | - | red maple (Acer rubrum L.) |
| Common names: | - | soft maple, white maple, swamp maple |
| Field identification aids: | - | leaf margins have many teeth |
| | - | sharp corner on leaf margin between lobes |
| | - | twigs are a deep red, often with branching perpendicular to main branch |
| | - | blunt buds (sugar maple buds are smaller and sharp) |
| Average mature tree: | - | 50 to 60 years old |
| | - | 18 m to 22 m (60' to 70') tall |
| | - | 30 cm to 46 cm (12" to 18") at diameter 1.3 m (4.5') from ground |
| Tolerance: | - | medium |
| Rooting: | - | shallow, widespreading lateral roots, occasionally with a small tap root |
| Reproduction: | - | reproduces by seed, stump sprouting, and suckering |
| | - | tree may begin to produce seed when 30 years old, with full crop production after 40 years |
| | - | good seed crop production almost every year |
| | - | best germination on a moist mineral soil with a light leaf cover |
| Growing sites: | - | range from poorly drained to dry upland site |
| | - | best growth is on well drained sites |
| | - | usually grows on moderately drained soils, but are very common around swamps |
| Associated species: | - | black spruce and balsam fir on poorly drained sites |
| | - | balsam fir, red spruce and yellow birch on well drained sites |
| | - | rarely found in pure stands |
| Windfirmness: | - | moderately windfirm |

| | | |
|---|---|---|
| **Principal enemies:** | - | deer, moose and rabbit browsing |
| **Notes:** | - | comprises 15.1% of merchantable volume of Nova Scotia forests and is on the increase |
| | - | an increasing component of mixedwood stands due to regular seed production, ease of sprouting, medium tolerance, and continued partial cutting |
| | - | branches are prone to breakage during winter storms |
| | - | saplings are split and used to make baskets |

## SILVICS OF YELLOW BIRCH

| | | |
|---|---|---|
| Species: | - | yellow birch (Betula alleghaniensis Britt.) |
| Common names: | - | curly birch, hard birch, black birch |
| Field identification aids: | - | leaves are oval shaped with many teeth along the margins |
| | - | yellow to golden papery bark that peels off in thin strips |
| | - | bark of older tree is platy and dark |
| | - | woody twigs have a wintergreen taste |
| Average mature tree: | - | 70 to 90 years old |
| | - | 18 m to 24 m (60' to 80') tall |
| | - | 30 cm to 60 cm (12" to 24") diameter at 1.3 m (4.5') from the ground |
| Tolerance: | - | medium |
| Rooting: | - | deep, widespreading lateral roots |
| Reproduction: | - | reproduces by seed or stump sprouting |
| | - | tree may begin to produce seed when 40 years old, with full production after 70 years |
| | - | good seed crop production every 1 to 2 years |
| | - | poor germination on undisturbed litter layer |
| | - | best seed germination occurs on a moist humus mineral soil |
| Growing site: | - | range from well drained to poorly drained soils |
| | - | best growth is on moderately drained loam soil |
| | - | usually found on moderate to well drained soils |
| Associated species: | - | black spruce and red maple on poorly drained sites |
| | - | sugar maple, red maple, beech, red spruce, eastern hemlock and balsam fir on well drained sites |
| | - | seldom found in pure stands in Nova Scotia |
| Windfirmness: | - | windfirm on well drained soils |

Principal enemies:

- leaf miner, bronze birch borer, and white-marked tussock moth cause some damage

Notes:

- comprises 5.8% of merchantable volume of Nova Scotia forest
- favourite hardwood browse of deer
- the tree often has stilted roots due to germination occurring on dead tree or stump
- usually found growing on old decaying stumps
- birch dieback is a common disorder
- one of Nova Scotia's most valuable hardwoods
- the most valuable of the native birches
- commonly used for flooring, furniture, cabinet work, and veneer

## SILVICS OF WHITE BIRCH

| | | |
|---|---|---|
| Species: | - | white birch (Betula papyrifera Marsh) |
| Common names: | - | paper birch, canoe birch, silver birch |
| Field identification aids: | - | papery white bark that peels off in sheets covers trunk of mature tree |
| | - | very few branches below the crown of a mature tree |
| Average mature tree: | - | 60 to 70 years old |
| | - | 15 m to 21 m (50' to 70') tall |
| | - | 25 cm to 60 cm (10" to 24") diameter at 1.3 m (4.5') from the ground |
| Tolerance: | - | intolerant |
| Rooting: | - | deep, spreading lateral roots |
| Reproduction: | - | reproduces by seed or stump sprouting |
| | - | tree may begin to produce seed when 15 years old, with full crop production after 40 to 70 years |
| | - | generally a good seed crop is produced every year |
| | - | best seedbed germination occurs on moist mineral soil |
| | - | poor germination on leaf litter or duff |
| Growing sites: | - | range from moderately drained to dry sites |
| | - | best growth on well drained, sandy loam |
| Associated species: | - | aspen, pin cherry and grey birch on recent cutover and burned sites |
| | - | occasionally grows in pure stands |
| Windfirmness: | - | only moderately windfirm |

Principal enemies:

- bronze birch borer and birch leaf skeletonizer cause local damage

Notes:

- comprises 2.8% of merchantable volume of Nova Scotia forests
- tree can be damaged or killed if the bark is stripped off
- fast growing, short lived tree
- birch dieback causes some mortality
- used for turning, pulpwood, and fuelwood
- a true pioneer species

## SILVICS OF GREY BIRCH

| | | |
|---|---|---|
| Species: | - | grey birch (Betula populifolia Marsh) |
| Common names: | - | wire birch, white birch |
| Field identification: | - | triangular leaves, warty, wire-like twigs |
| | - | tight, non-peeling, greyish bark with black, triangular markings where branches join trunk |
| Average mature tree: | - | 30 to 50 years old |
| | - | 6 m to 11 m (20' to 35') tall |
| | - | 8 cm to 12 cm (3" to 5") diameter 1.3 m (4.5') from the ground |
| Tolerance: | - | intolerant |
| Rooting: | - | shallow laterals, no tap root produced |
| Reproduction: | - | reproduces by seed or stump sprouting |
| | - | prolific seeder |
| | - | full seed crop production after 30 years |
| | - | good seed crop production every year |
| | - | best germination occurs on moist, mineral soil |
| Growing sites: | - | range from dry to poorly drained |
| | - | best growth on well drained sites |
| | - | usually found on recent cutovers, burnt areas, and abandoned pastures |
| Associated species: | - | alders and larch on poorly drained sites |
| | - | white birch, pin cherry and aspen on well drained sites |
| | - | occasionally found in pure stands |

Principal enemies: - leaf miner

Notes:
- not a commercial species
- rarely attains merchantable size, but can be used for fuelwood

## SILVICS OF WHITE ASH

| | | |
|---|---|---|
| Species: | - | white ash (Fraxinus americana L.) |
| Common names: | - | ash, American ash |
| Field identification aids: | - | tree is usually straight, with a cylindrical bole |
| | - | bark contains many deep vertical furrows |
| | - | buds are opposite (maples are the only other species with opposite buds) |
| | - | first set of lateral buds touch the terminal bud |
| | - | compound leaves |
| Average mature tree: | - | 60 to 80 years old |
| | - | 18 m to 21 m (60' to 70') tall |
| | - | 45 cm to 75 cm (18" to 30") diameter at 1.3 m (4.5') from the ground |
| Tolerance: | - | medium |
| | - | can withstand moderate shade in youth, but requires more sunlight as it matures |
| Rooting: | - | widespreading lateral roots will grow deep if the soil conditions permit |
| Reproduction: | - | reproduces by seed or stump sprouting |
| | - | tree may begin to produce seed when 20 to 30 years old, with good crop production after 40 to 50 years |
| | - | good seed crop production almost every year |
| | - | germination is best under full sunlight on a moist, mineral soil |
| Growing sites: | - | range from moderately drained to well drained |
| | - | grows best on deep, moist soils |
| Associated species: | - | beech, white birch, yellow birch, sugar maple, and hemlock on well drained sites |
| Windfirmness: | - | windfirm |

Principal enemies:

- forest tent caterpillar does some damage
- ash rust causes distortion of leaves and tree form; alternate hosts of this rust are marsh and cord grasses

Notes:

- with red oak, comprises 1.7% of merchantable volume of Nova Scotia forests
- highly prized for its strong, shock resistant wood which makes excellent tool handles and sporting goods

## SILVICS OF RED OAK

| | | |
|---|---|---|
| Species: | - | red oak (Quercus rubra L. Michx.f.) |
| Common names: | - | oak, northern red oak |
| Field identification aids: | - | only native oak in Nova Scotia |
| | - | dark green leaves with 7 to 11 bristle-tipped lobes |
| | - | large, sturdy tree that bears acorns |
| | - | cluster of buds at top of twig |
| Average mature tree: | - | 70 to 90 years old |
| | - | 15 m to 21 m (50' to 70') tall |
| | - | 30 cm to 75 cm (12" to 30") diameter of 1.3 m (4.5') from ground |
| Tolerance: | - | medium |
| Rooting: | - | deep spreading lateral roots with a tap root |
| Reproduction: | - | reproduces by seed or stump sprouting |
| | - | tree may begin to produce seed when 25 years old, with full crop production after 50 years |
| | - | good seed crop production every 2 to 5 years |
| | - | best seed germination occurs on moist soil covered by litter |
| | - | poor germination on dry or exposed soil |
| Growing sites: | - | range from deep stone free to shallow rocky sites |
| | - | best growth is on fine textured soils with high water table |
| Associated species: | - | aspen, white birch and red maple on poor sites |
| | - | sugar maple, yellow birch, white ash, red spruce, red pine, and white pine on good sites |
| | - | can occur in pure stands, especially in Queens County |
| Windfirmness: | - | good windfirmness on average sites |

| | | |
|---|---|---|
| Principal enemies: | - | oak leaf-shredder, winter moth |
| Notes: | - | with white ash, comprises 1.7% of merchantable volume of Nova Scotia forests |
| | - | wood used for flooring, interior finish and furniture |
| | - | good quality trees are very valuable as shipbuilding lumber |

## SILVICS OF BEECH

| | | |
|---|---|---|
| Species: | - | beech (Fagus grandifolia Ehrh.) |
| Common names: | - | American beech |
| Field identification aids: | - | beech retain their leaves through most of the fall and early winter |
| | - | the trunk and branches are often gnarled and crooked because of fungus |
| | - | the leaf buds are long with sharp ends |
| Average mature tree: | - | 60 to 80 years old |
| | - | 12 m to 21 m (40' to 70') tall |
| | - | 20 cm to 60 cm (8" to 24") diameter at 1.3 m (4.5') from ground |
| Tolerance: | - | very tolerant |
| Rooting: | - | shallow, wide spreading lateral roots |
| Reproduction: | - | reproduces by seed, stump sprouting, or suckering from exposed roots |
| | - | tree may begin to produce seed when 40 years old, with full crop production after 60 years |
| | - | good seed crop produced every 2 to 3 years |
| | - | best seed germination occurs on moist humus or mineral soil |
| | - | poor seed germination on wet sites |
| Growing sites: | - | range from moderately drained to well drained |
| | - | best growth on well drained loam sites |
| Associated species: | - | red maple, sugar maple, yellow birch, red spruce, and hemlock on well drained sites |
| | - | rarely found in pure stands |
| Windfirmness: | - | moderately windfirm |

| | | |
|---|---|---|
| Principal enemies: | - | beech bark scale and nectria funugs (insect-fungal partnership) |
| Notes: | - | comprises 2.4% of merchantable volume of Nova Scotia forests |
| | - | a decrease in quality of beech due to heavy damage sustained by the introduction of nectria fungus by beech scale insect |
| | - | used primarily for fuelwood |

## SILVICS OF TREMBLING ASPEN

| | | |
|---|---|---|
| Species: | - | trembling aspen (Populus tremuloides Michx.) |
| Common names: | - | aspen, poplar, popple, quaking aspen |
| Field identification aids: | - | finely serrated leaf margin |
| | - | leaves turn yellow in fall |
| | - | leaf stem is often longer than the leaf itself |
| | - | leaves vibrate vigorously in slight wind |
| | - | bark on younger trees is smooth, pale green, but becomes grey and furrowed with age |
| Average mature tree: | - | 40 to 60 years old |
| | - | 12 m to 18 m (40' to 60') tall |
| | - | 25 cm to 40 cm (10" to 16") diameter at 1.3 m (4.5') from the ground |
| Tolerance: | - | very intolerant |
| Rooting: | - | shallow, lateral roots |
| Reproduction: | - | reproduces by seed, sprouting, and suckering of roots |
| | - | tree may begin to produce seed when 20 years old, with full crop production after 30 years |
| | - | full seed crop production every 4 to 5 years |
| | - | best seed germination occurs on a moist mineral soil |
| Growing sites: | - | range from dry rock outcrops to bogs |
| | - | best growth on well drained moist loam soil |
| | - | usually found on cutover and burned sites |
| Associated species: | - | largetooth aspen, white spruce, balsam fir, white birch, and red spruce on well drained sites |
| | - | often found in pure stands |
| Windfirmness: | - | moderately windfirm |

| | | |
|---|---|---|
| Principal enemies: | - | hypoxylon canker |
| | - | forest tent caterpillar |
| Notes: | - | all aspens comprise 3.1% of merchantable volume of Nova Scotia forests |
| | - | beaver often use aspen for food and shelter |
| | - | trembling aspen is the fastest growing hardwood in Nova Scotia |
| | - | has limited use for pulpwood and fuelwood |

## SILVICS OF LARGETOOTH ASPEN

| | | |
|---|---|---|
| Species: | - | largetooth aspen (Populus grandidentata Michx.) |
| Common names: | - | aspen, poplar, bigtooth aspen |
| Field identification aids: | - | large teeth around the entire leaf margin |
| | - | smooth green bark when immature; dark grey and furrowed when older |
| Average mature tree: | - | 40 to 60 years old |
| | - | 12 m to 18 m (40' to 60') tall |
| | - | 30 cm to 48 cm (12" to 18") diameter at 1.3 m (4.5') from ground |
| Tolerance: | - | very intolerant |
| Rooting: | - | shallow spreading lateral roots |
| Reproduction: | - | reproduces by seed, sprouting, and by suckering of roots |
| | - | tree may begin to produce seed as early as 20 years old, with full crop production after 30 years |
| | - | good seed crop every 4 to 5 years |
| | - | best seed germination occurs on moist mineral soil under full sunlight |
| Growing sites: | - | range from moderately drained to dry |
| | - | best growth on well drained loam soils |
| | - | usually found on recent cutovers and burned sites |
| Associated species: | - | trembling aspen, white birch, grey birch, pin cherry, white spruce, and balsam fir on well drained soils |
| | - | occasionally found in pure stands |
| Windfirmness: | - | moderate to well drained sites |

| | | |
|---|---|---|
| Principal enemies: | - | hypoxylon canker and forest tent caterpillar |
| Notes: | - | all aspen comprise 3.1% of merchantable volume of Nova Scotia forests |
| | - | short-lived tree that is capable of rapid growth on favourable sites |
| | - | wood can be used for pulpwood, pallets, and fuelwood |

## SILVICS OF PIN CHERRY

| | | |
|---|---|---|
| Species: | - | pin cherry (Prunus pensylvanica L.F.) |
| Common names: | - | fire cherry, hay cherry, red cherry, bird cherry |
| Field identification aids: | - | small tree that rarely exceeds 8 m (25') tall |
| | - | bark of young cherry resembles that of a young birch sapling |
| | - | bark of older cherry is dotted with light brown markings |
| | - | branches often exhibit black wart-like cankers |
| | - | buds smell like almonds when crushed |
| | - | berry is sour tasting |
| | - | black knot fungus |
| Average mature tree: | - | 20 to 30 years old |
| | - | 3 m to 8 m (10' to 25') tall |
| | - | 10 cm to 15 cm (4" to 6") diameter at 1.3 m (4.5') from ground |
| Tolerance: | - | very intolerant |
| Rooting: | - | moderately deep and widespreading |
| Reproduction: | - | reproduces by seed |
| | - | seed is heavy and is dispersed by birds |
| | - | seed remains viable in the soil for long periods |
| Growing sites: | - | occurs on burned areas, along rivers, and fence rows |
| | - | prefers sandy soil |
| | - | cutovers |
| Associated species: | - | white and grey birch, trembling aspen, and alder |

| | | |
|---|---|---|
| **Principal enemies:** | - | **black knot fungus** |
| Notes: | - | pin cherry is not a commercial species |
| | - | favourite food for birds |
| | - | twigs and leaves contain cyanic acid and are poisonous |
| | - | pioneer species |

"Trees of Nova Scotia" provides a complete list of additional native and introduced hardwoods that grow here in insignificant amounts.

## QUIZ

**True or False**

_____ 1. Sugar maple has opposite buds.

_____ 2. Red maple is a shade tolerant tree.

_____ 3. Yellow birch seed requires a mix of litter and mineral soil to germinate.

_____ 4. White birch is also known as paper birch.

_____ 5. Grey birch is an important commercial tree species.

_____ 6. White birch is a tolerant tree.

_____ 7. Red oak is not prone to windthrow.

_____ 8. Healthy beech stands occur throughout the province.

_____ 9. Aspen leaves shake in light winds.

_____ 10. Pin cherry is not a pioneer species.

## LESSON FOUR

## STAND GROWTH AND DEVELOPMENT

### Introduction

To practice good forest management, the woodlot owner must understand what a tree is, how it grows, and how growth can be influenced.

A tree is made up of roots, a trunk or stem, and a crown. Each of these parts play an important role in the tree's growth and development. The roots anchor the tree to the ground and absorb moisture and nutrients from the surrounding soil. The trunk supports the crown and is the link between the roots and leaves for transporting water and nutrients. Water, nutrients, the sun's energy, and gases from the air combine in the leaves to produce the food needed for survival.

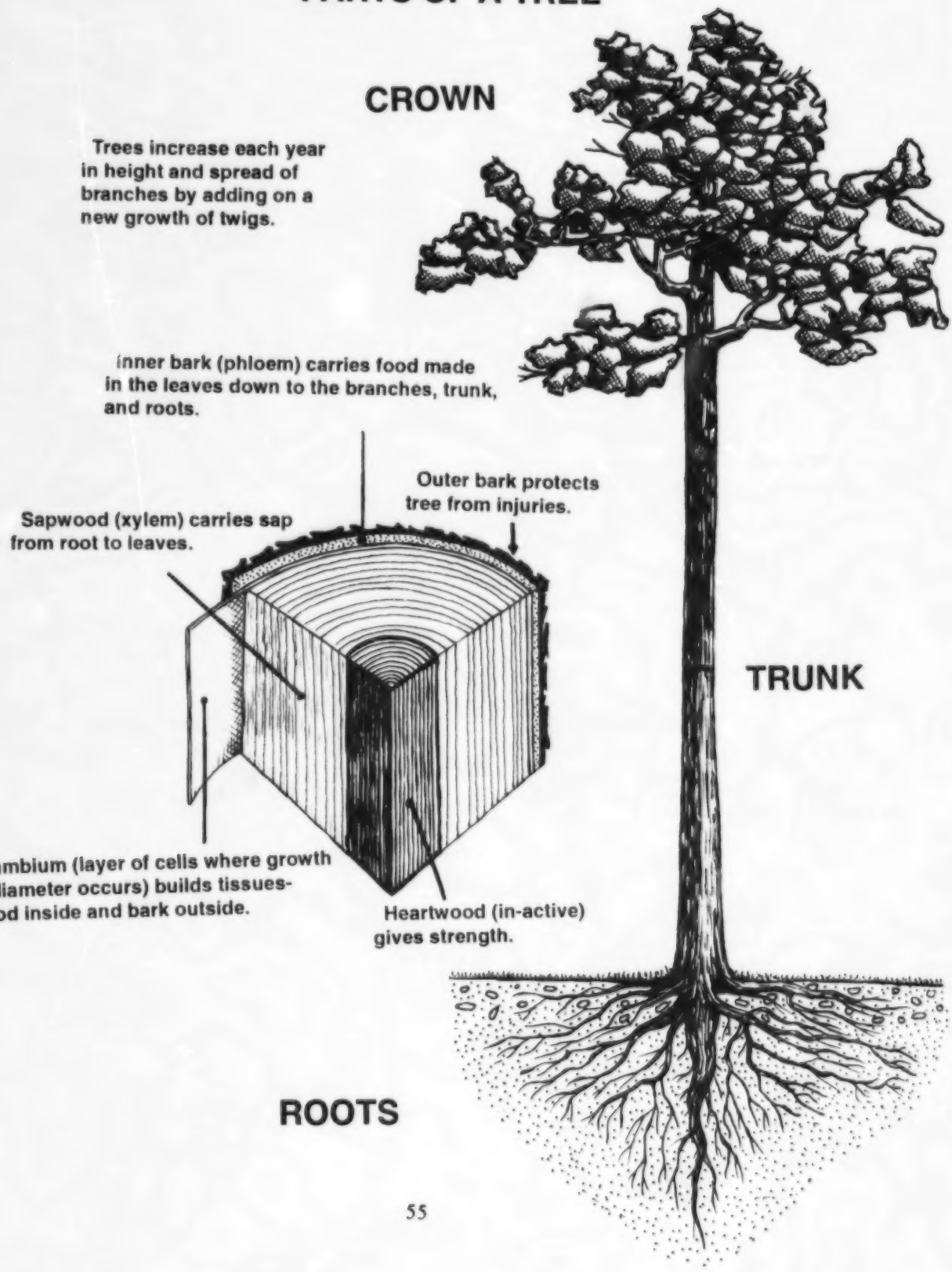
The roots, trunk and branches are made up of the following (Figure 6):

| | |
|---|---|
| Heartwood | An inactive wood that does not have a role in the production of food for the tree. It gives strength to the roots, trunk and branches. |
| Sapwood | Made up of xylem tissue, this active wood carries water and nutrients from the roots to the leaves or needles in the crown. |
| Cambium | The layer of cells where diameter growth occurs. It is a sheath of tissue located under the bark next to the sapwood. The inside layer closest to the centre of the tree produces wood. The outside layer produces bark. |
| Inner bark | Consisting of tissue called phloem, it carries food made in the leaves and needles down to the branches, trunk, and roots. |
| Outer bark | Protects the tree from injury. |

Roots, stems, and branches lengthen and thicken as a tree grows. Silvicultural treatments can influence the amount and rate of these changes. For example, an appropriate silvicultural treatment, such as an early thinning, can bring a stand to harvest size 20 years before an untreated stand.

Figure 6

# PARTS OF A TREE


CROWN
Trees increase each year in height and spread of branches by adding on a new growth of twigs.
Inner bark (phloem) carries food made in the leaves down to the branches, trunk, and roots.
Outer bark protects tree from injuries.
Sapwood (xylem) carries sap from root to leaves.
TRUNK
Cambium (layer of cells where growth in diameter occurs) builds tissues- wood inside and bark outside.
Heartwood (in-active) gives strength.
ROOTS

To assist in management planning and in implementing silvicultural treatments, a forest is divided into units called "stands" (Figure 7). Stands are groups of trees that show enough similarities in species, age, height, and density to form obvious separate units.

Evenaged stands are groups of trees with maximum age differences of 10 to 20 years. They are established after trees in an area are removed over a short period of time by fire, insect and disease attack, wind, or cutting. Unevenaged stands are trees with at least three age classes and have a variation in heights and diameters.

Since stands may be comprised of several species in varying amounts, they are further classified by the percentage of hardwoods and softwoods:

| | |
|---|---|
| Softwood | stands containing 76% to 100% softwood trees |
| Mixedwood | stands containing 26% to 75% softwood trees |
| Hardwood | stands containing 25% or less softwood trees |

Based on average height and age, stands may also be mature or in another stage of development (Figure 8).

A forest is a complex and dynamic community in which trees grow and develop from seedlings through to maturity. A number of physical and biological factors continually influence the growth and development of forests and must be understood before you can begin to practice good forestry.

Although the effect of these factors may be more easily understood when discussed individually (eg., soils), it is more complicated when all factors are considered together in the entire natural ecosystem. Nevertheless, an appreciation of their existence and effect on the forest will help you understand the reasons behind good silvicultural practices.

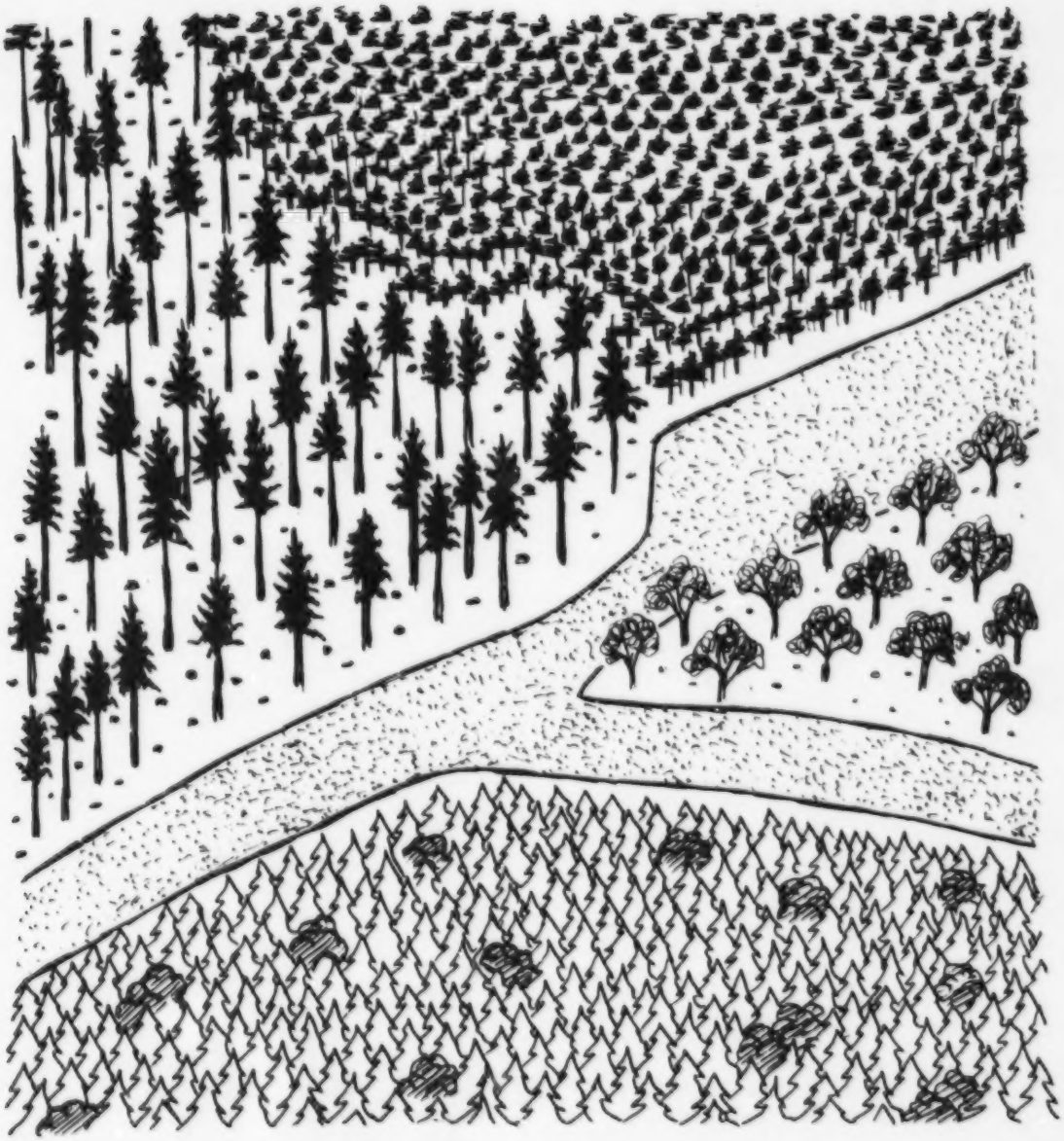
The following is a list of the major physical and biological factors which affect trees as they grow from the seedling stage to maturity:

Physical

(1) Climate
- temperature (average and extreme)
- rainfall (average and extreme)
- wind (average and extreme)
- severity and regularity of damaging storms (for example, hurricanes and sleet storms)

Figure 7

# A FOREST STAND



# STAGES OF STAND DEVELOPMENT

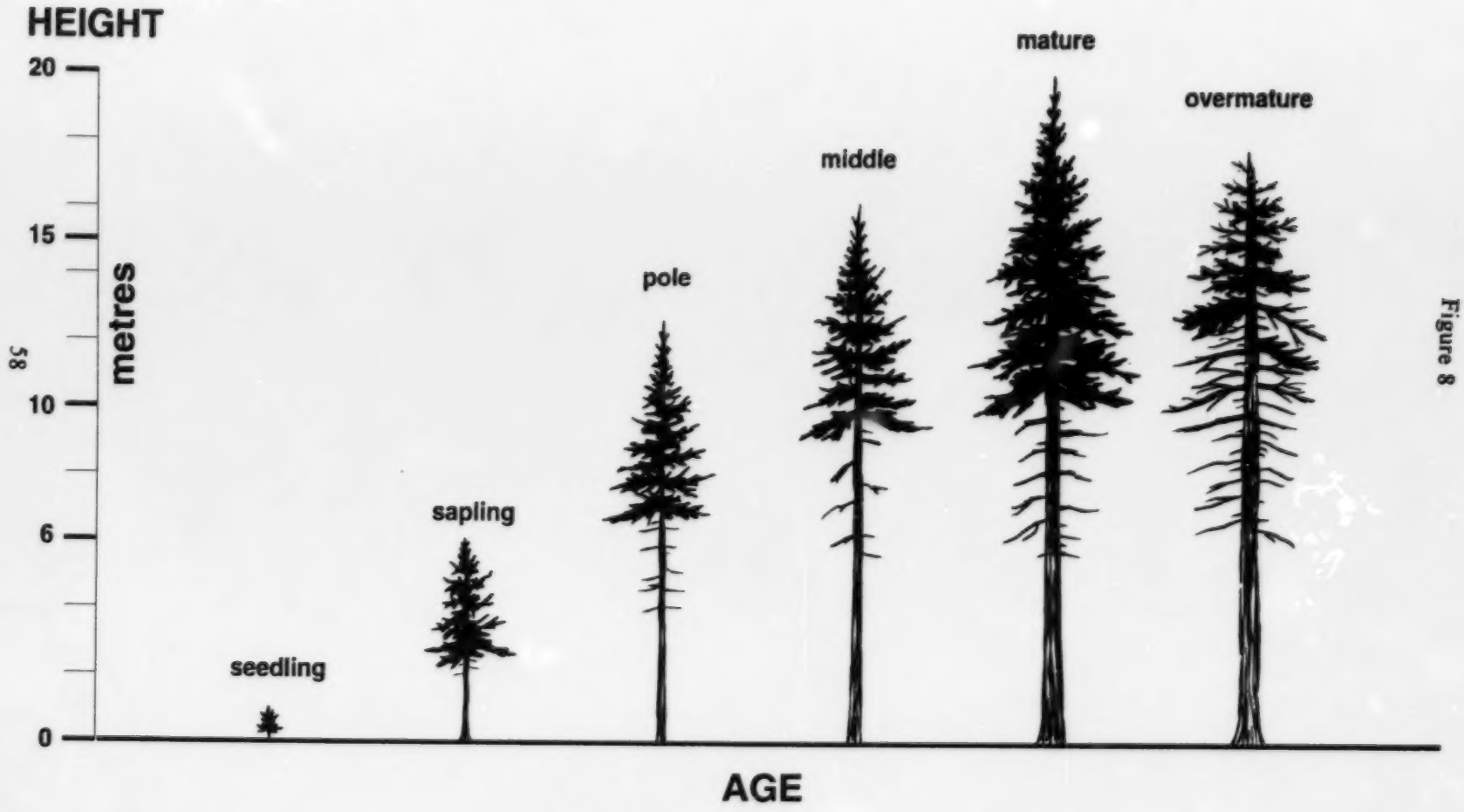



Figure 8

| | | |
|---|---|---|
| (2) Soils | - | structure (loose or compact) |
| | - | texture (clay, sand, or gravel) |
| | - | fertility |
| | - | depth |
| | - | drainage |
| | - | ground vegetation |
| (3) Location | - | altitude |
| | - | slope (%) |
| | - | orientation or direction of slope |
| | - | exposure |

Biological

| | | |
|---|---|---|
| (1) Silvics of each tree | - | reproductive capacity |
| | - | shade tolerance |
| | - | rooting capacity |
| | - | growth potential |
| | - | resistance to insects and diseases |
| (2) Stand features | - | density (trees/ha) |
| | - | species composition and distribution |
| (3) Damaging Agents | - | diseases |
| | - | insects |
| | - | mammals |
| | - | mechanical |

When managing a woodlot, it is important to know which biological factors can be changed and which physical factors cannot. For example, since the soil cannot be easily changed, the species you plant and/or the regeneration you try to encourage must be compatible with the soil type. You could try a number of silvicultural treatments and still not achieve maximum growth if the trees are not suited to the soil. Well known to farmers, fertilization is currently considered uneconomical for Nova Scotia forests.

Experience is very important. Woodlot operators who observe local conditions within his or her own region can provide valuable practical knowledge in addition to general silviculture principles.

## SITE CAPABILITY

The ability of a forest to grow is related directly to the physical site factors. Favourable physical factors create a better land capability rating and a better response to silvicultural treatments. Land capability is determined by comparing the total age of a healthy dominant tree to its total height. Better site qualities produce taller trees at any given age. For example, a 70 year old tree 23 metres (75') tall is growing on a better site than the same 70 year old tree that is only 16 metres (52') tall.

Land capabilities are classified by number. The best is land capability 13, capable with management, of producing 13 cubic metres per hectare per year ($m^3$/ha/yr) (2.3 cords/acre/year). The worst is land capability 1, capable of producing only 1 $m^3$/ha/yr (0.2 cds/ac/yr) even under management. Examples of the expected growth rates for different site classes are listed below:

1) A stand growing on a site class 7 takes an average of 7 years to reach a height of 3 m (10')

2) A stand growing on a site class 5 takes an average of 10 years to reach a height of 3 m (10')

3 A stand growing on a site class 4 takes an average of 15 years to reach a height of 3 m (10')

Sites lower than capability 4 (capable of 4 $m^3$/ha/yr) (0.7 cds/ac/yr) are not generally worth spending a lot of time and money on. The potential of the site to respond to a treatment is very low.

## GROWTH

As trees age they go through three major phases of development - immaturity, maturity, and decline. Through each phase, changes occur in the rate of height, diameter and volume growth; stand density, stocking and development; and species composition (Figure 9a).

## HEIGHT GROWTH

Trees grow in height from the terminal or top bud. The greatest rate of height growth happens during the immature stage (Figure 9b). Although a tree will continue to grow in total height, the rate will decrease as the tree matures. The final height that a healthy, vigorous tree reachs depends on the site capability. The better the site, the taller a tree will be at a given age.

# ANNUAL GROWTH CHANGE

Figure 9a

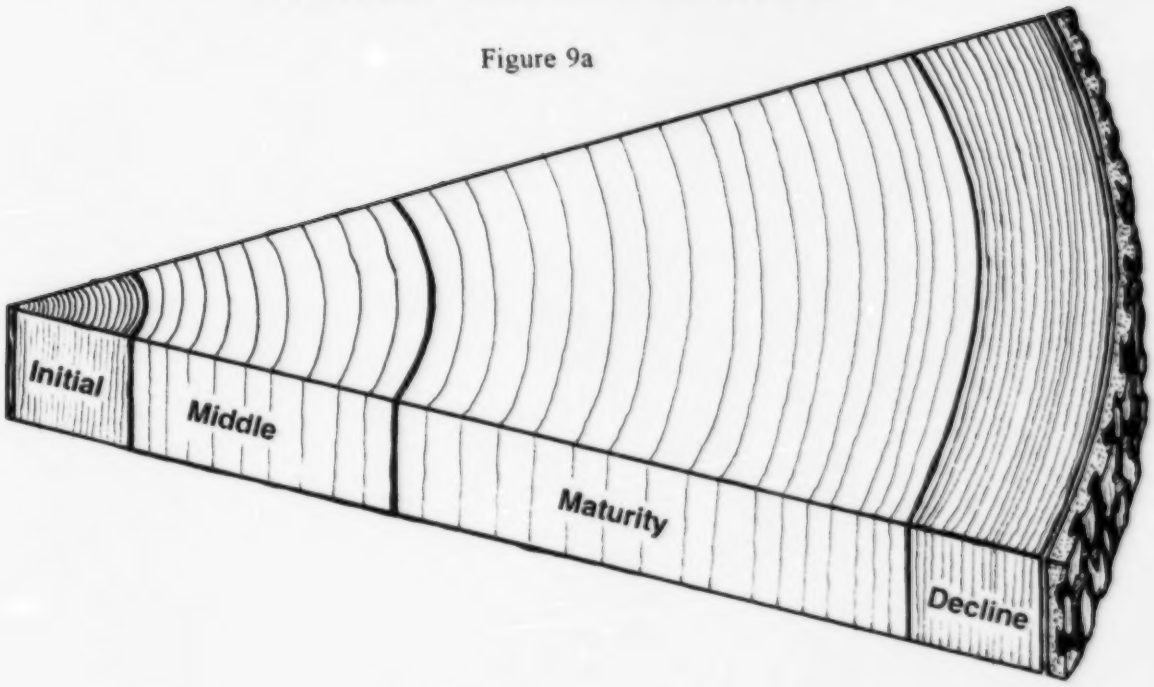
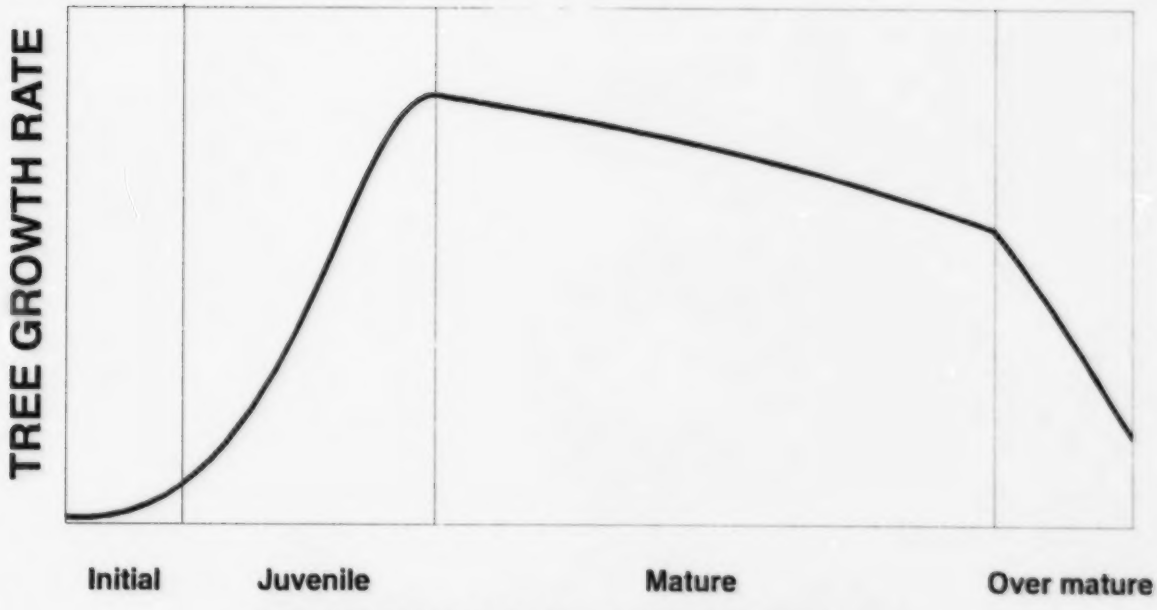



Figure 9b




**A SAMPLE DIAGRAM OF TREE GROWTH DURING THE FOUR STAGES OF DEVELOPEMENT.**

## DIAMETER GROWTH

Each year, a tree produces an annual ring made up of a light and dark band of wood. The light band occurs during the spring and early summer. The dark bands are produced in late summer and early fall. These rings occur on the trunk, roots, rootlets, branches and twigs of all trees (Figure 10). Annual rings are very important in forestry since they reflect the history of a tree or stand. A tree's age can be determined by counting the rings. The rate of diameter growth throughout a tree's life can be seen in the various widths of the rings. When a tree is suppressed, the rings are narrow and when the tree is growing well and free of competition, the rings are wide.

The rate of diameter growth is directly related to stocking. Generally, the greater the stocking the slower the rate of diameter growth. Diameter growth is reduced by suppression from the side and from above. If a tree is released from competition, the rate of diameter growth will normally increase. Constant competition throughout the tree's life will result in a smaller diameter tree at maturity, regardless of the site capability.

If a tree is suppressed on one side only, the diameter growth will normally be less on the suppressed side. For example, trees along the edge of a field will usually more diameter growth on the side facing the field, while the forested side will have less.

Because of the competition in a stand, trees of the same age may exhibit a wide variation in diameters. A tree with a large diameter could be the same age or younger than a neighbouring tree with a smaller diameter.

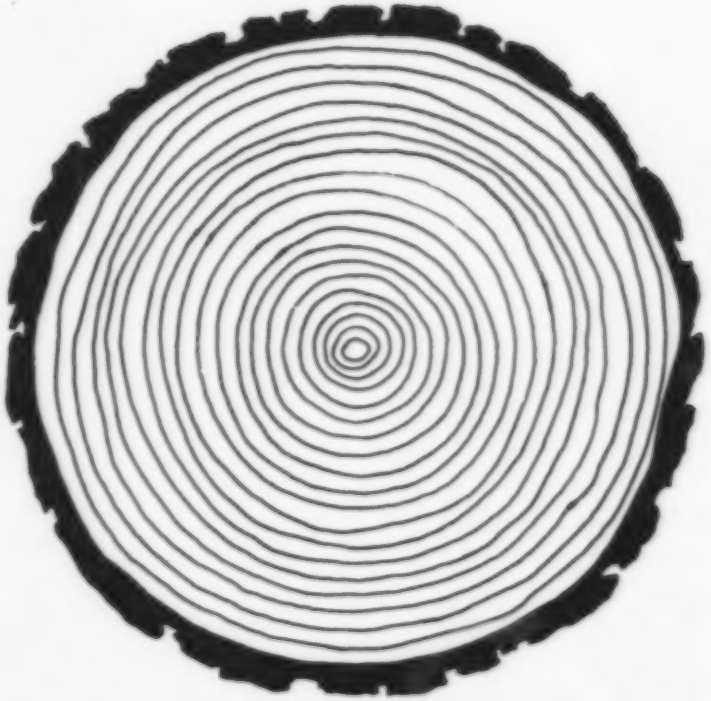
Reducing competition by thinning allows the remaining trees to grow to the site's capability. Thus, more merchantable wood will be produced sooner. The extra space will also allow the tree to develop straighter stems that will have a higher value, such as sawlogs.

## VOLUME GROWTH

The rate of volume growth, like height and diameter growth, is generally greater during the early stages of a tree's development. Since volume growth is dependent upon both height and diameter growth, factors that influence height and diameter will also affect the volume.

However, stand volume is directly related to stocking. That is, stand volume will increase as stocking increases (Figure 11) because the site is being more fully utilized.

## ANNUAL RINGS



FREE GROWN

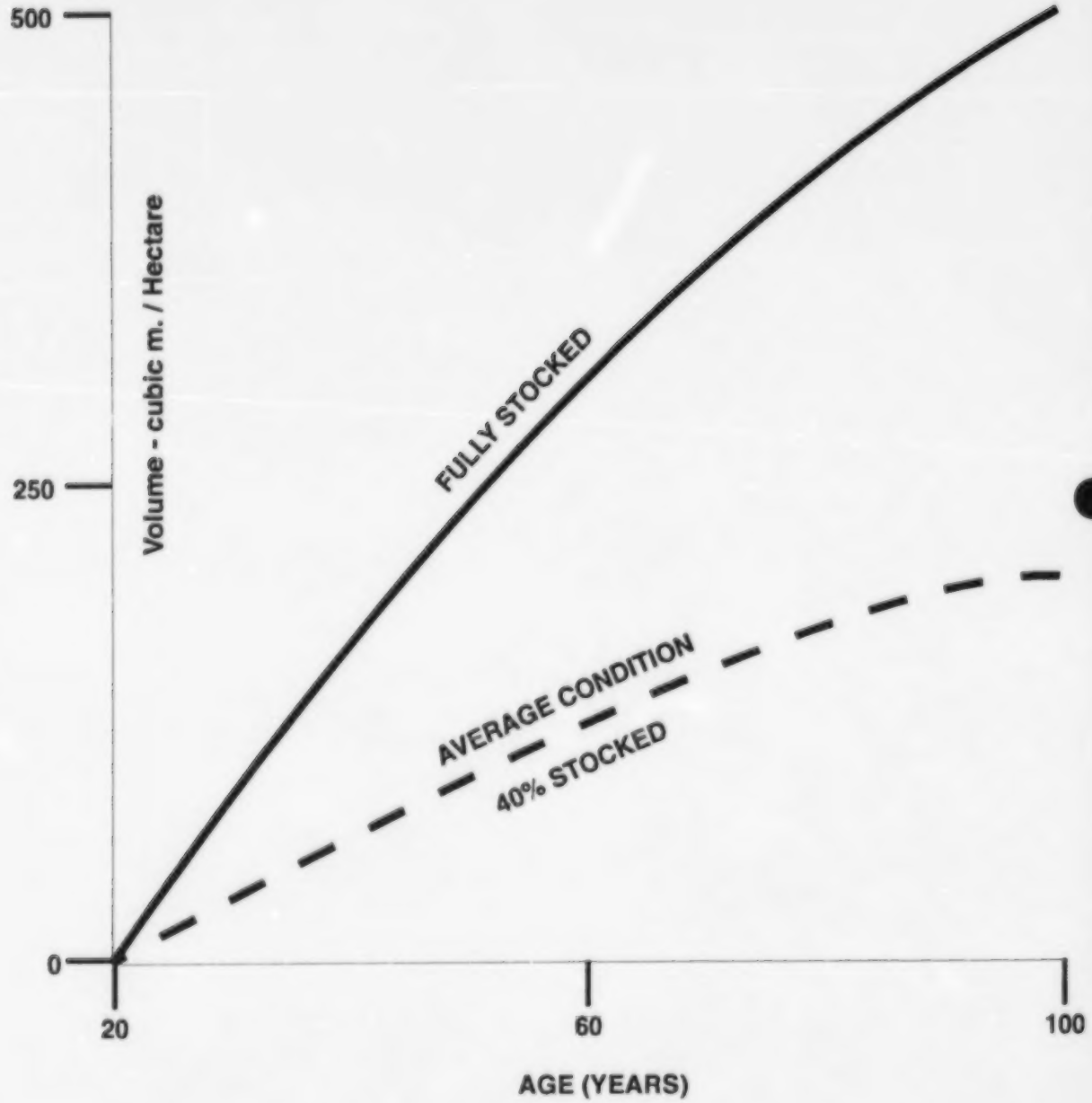
SUPPRESSED

(BOTH 20 YEARS OF AGE)

Figure 10

Figure 11

# VOLUME CURVE FOR MEDIUM SITE (METRIC)



## STAND DENSITY AND STOCKING

In growing from seedling to maturity, trees constantly compete for sunlight, moisture, food, and space. The healthier, vigorous trees on better sites soon overtop their neighbours and become dominant and codominant members of the stand. The remaining trees develop into intermediate or suppressed positions within the stand (Figure 12).

Genetically superior trees and more vigorous species have an advantage and often quickly establish superior height positions in the forest canopy. Inferior trees are at a distinct disadvantage.

Density is usually expressed as number of trees per unit area (hectare or acre). It reflects the degree of crowding of trees in a stand. Stocking is a relative term usually expressed as a percentage, which refers to amount of growing space used by trees. An area that supports sufficient trees to use all the available growing space is 100% stocked. An area where only half of the available growing space is occupied by trees is 50% stocked.

During stand establishment, thousands of trees may germinate, but that number will decrease through natural mortality as the stand ages. The higher the initial density, the greater the competition, resulting in many trees being eliminated from the stand. At maturity, the available sunlight, moisture, nutrients, and space will be used by fewer, larger trees.

When a tree dies, it creates an opening in the forest canopy. As it decays, nutrients stored in the foliage and wood fibre are released into the soil. In a young stand, the opening is filled by the branches of the surrounding trees. In a mature stand the open space provides an area where regeneration can establish.

Throughout its life, a tree must have enough space to spread its crown and roots in proportion to its size to reach maximum growth. If there are too many trees competing for the same space, the overall stand growth will be reduced. If there are not enough trees, the existing trees will develop large limbs and extensive crowns. Much of the growing space will be utilized by undesirable, non commercial species. This also results in an overall reduction of stand growth.

Figure 12

# CROWN CLASSES

A species' ability to survive in a dense stand depends on its height growth and to a greater extent, its tolerance of shade. Tolerant trees are able to survive and grow under various shade conditions. Intolerant trees cannot persist for very long in shade. It is important to consider this when planning silviculture operations. If your objective is to produce a stand of tolerant trees, a shelterwood or selection method of harvest should be used rather than a clearcut.

## SPECIES COMPOSITION

Species composition will vary throughout the life of a stand, depending on stand density and age. As stands get older intolerant species generally die and are replaced by more tolerant species which are better able to compete for the reduced available sunlight.

## MANIPULATION OF STANDS BY SPACING

As mentioned earlier, growth and development of a stand is significantly affected by competition with other trees. In some cases, competition is beneficial; such as in hardwood or white spruce stands where density will minimize excessive limbiness. In dense stands, competition from neighbouring trees slows the growth and development of the stand (Figure 13).

To enhance the growth and development of your woodlot, competition must be adjusted through spacing treatments. Precommercial and commercial thinnings are treatments used to achieve desired spacing. With the exception of planting, most silvicultural approaches to stand management involve altering the existing spacing.

Spacing treatments remove undesirable trees and free the best ones from competition. Undesirable trees are those that are diseased and/or damaged, unwanted species, and ones that are crowding better quality trees. Which trees are undesirable will vary with each situation. Therefore, it is important to always know what type of stand you want to encourage.

Figure 13

## QUIZ

**True or False**

_____ 1. A stand is a group of trees that show enough similarities in species composition, age, height and density to form a distinguishable unit.

_____ 2. Even aged stands are made up of groups of trees with maximum age differences of 1 to 2 years.

_____ 3. Physical factors affecting tree growth can be influenced and biological factors cannot be influenced when managing a woodlot.

_____ 4. The ability of a forest to produce trees is related directly to the physical factors of the site.

_____ 5. The rate of tree height growth is primarily dependent on the density of the stand.

_____ 6. Tree diameter is primarily dependent on the density of the stand.

_____ 7. In the forestry sense, stocking is a subjective indication of the number of trees, compared to a desirable number of trees.

_____ 8. Tolerant trees have the ability to survive and grow under various shade conditions.

_____ 9. There are two main phases of stand development - immaturity and maturity.

_____ 10. Spacing lengthens the time between merchantable crops.

## FOR FURTHER READING

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Hosie, R.C. . 1979. Native Trees of Canada. Ministry of Supply and Services Canada. 380 p.

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Single copies of the following are available free at your local Natural Resources office or by writing : NSDNR, P.O. Box 68, Truro, Nova Scotia, B2N 5B8.

Forestry Report - Nova Scotia's Forest Sector. 1993.

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Robertson, R.G., R. W. Young and J.C. Lees. 1991. Hardwood Thinning Manual. Dept. of Lands and Forests. 48 p.

Robertson, R.G. and R. W. Young. 1990. Merchantable Thinning Manual - Softwoods. Dept. of Lands and Forests. 48 p.

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## GLOSSARY

**ARTIFICIAL REGENERATION:** Establishing a forest by direct seeding and/or planting.

**ASPECT:** Direction towards which a slope faces; orientation of a slope face.

**BASAL AREA:** The area in square metres (square feet) of the cross section of the trunk of a tree at breast height. Most commonly used as an indicator of stand density and is expressed as square metres/hectare (square feet/acre).

**BIOLOGICAL:** Relates to living organisms with regard to inherent characteristics of living things which influence their growth and health.

**BLOWDOWN:** Trees uprooted by high winds, commonly called windthrow or blowdown.

**BREAST HEIGHT:** A distance 1.3 metres (4.5') above ground level.

**CAMBIUM:** A sheath of tissue located under the bark next to the sapwood.

**CANOPY:** Cover of branches and foliage formed by tree crowns.

**CLEARCUT:** The removal of all trees, regardless of size, from an area.

**CODOMINANT:** Trees with crowns forming the general level of the canopy which receive full light from above, but comparatively little from the sides. Trees have medium-sized crowns.

**COMMERCIAL THINNING:** A thinning producing commercial material at least to the value of the direct cost of the operation.

**CONES:** The fruiting bodies of coniferous trees which produce the seed.

**CONIFEROUS TREES:** Commonly called softwood or evergreen, trees that have cones and keep their needles throughout the winter. There are some exceptions.

**CROP TREE:** Any tree forming or selected to form part of the final harvest. Crop trees may be selected from an immature stand and carried through until final harvest.

**DECIDUOUS:** Commonly referred to as hardwoods or broad leaf trees, in most cases, they lose their leaves in the fall.

**DENSITY (STAND):** A measurement of the stand in terms of square metres of basal area, number of trees, or volume per hectare. It reflects the degree of crowding of stems within the stand. Expressed as basal area, it is a measurement of the portion of an area occupied by trees. Expressed as percentage of crown closure, it is an estimate of the extent the site is occupied.

**DISTRIBUTION:** The arrangement of stand characteristics such as height, age, diameter and species.

**DOMINANT:** Trees with crowns extending above the general level of the canopy and receiving full light from above and partial light from the sides. They are larger than the average trees of the stand with well developed crowns.

**DUFF:** The shallow layer of organic soil and litter of the forest floor which lies over the general mineral soil.

**EVENAGED STAND:** A stand of trees with maximum age differences of 10-20 years and of approximately the same height.

**FOREST:** A group or community of trees, plants, and animals often divided up into forest stands.

**FULL STOCKING:** A situation where the total capability of the land is being realized. Each tree should have the best space for adequate crown development and growth.

**GENETIC:** The inherent physiology and development of living organisms as determined by the genes.

**GIRDLE:** To encircle the stem of a living tree with cuts that completely sever bark and cambium and often are carried well into the outer sapwood, for the purpose of killing the tree by preventing the passage of nutrients.

**GROUND VEGETATION:** Non-woody vegetation under 1.2 metres (4') in height.

**HARDPAN:** A band or layer of soil which impedes drainage and inhibits root penetration caused by iron build-up during leaching process.

**HIGH-GRADING:** Harvesting the biggest, best and most profitable trees and leaving the less desirable trees.

**IMMATURE STAND:** A stand of young trees past the regeneration stage usually showing good health and vigour.

**INTERMEDIATE:** Trees with crowns extending into canopy formed by dominant and codominant trees which receive a little light from above, but not from the sides.

**INTOLERANT:** The inability of a tree to maintain health and vigour under shade. Intolerant trees require full sunlight to maintain vigorous growth. Referred to as pioneer species.

**LATERAL ROOTS:** Relatively shallow roots which spread outward from the tree parallel to the ground.

**LAYERING:** A method of reproduction in which living lower branches come in contact with moist ground or are covered with litter and produce roots. These branches eventually grow into trees separate from the parent tree. It is a common reproduction method of black spruce.

**MATURE STAND:** A stand of trees is considered mature when height, diameter and volume growth level off. Different species mature at different ages.

**MICROCLIMATE:** A small area with different climatic conditions than the surrounding area (example: depressional areas).

**MINERAL SOIL:** Soil containing a high percentage of inorganic material such as rock, sand, clay and silt.

**ORGANIC SOIL:** Soil containing a high proportion of dead or decaying plant matter from fallen material such as needles and leaves, slash and blowdown.

**PHENOTYPIC:** A tree's growth characteristics caused by its environment; good phenotypic features are full crown, straight bole and dense foliage.

**PHOTOSYNTHESIS:** The process by which green plants convert water, carbon dioxide and sunlight into organic compounds used to sustain life.

**PRECOMMERCIAL THINNING:** A spacing treatment carried out in young natural stands which removes competition and releases desired trees.

**REGENERATION:** The reforestation or reproduction of the forest by either natural seeding or artificial means. Generally refers to established seedlings.

**RELEASE:** The removal of competing vegetation and/or trees so that favoured young growth can benefit from more light and growing space.

**RESIDUAL TREES:** Scattered, standing trees left by cutters in an area which has undergone extensive harvesting.

**ROTATION:** The period of years required to establish and grow timber crops to a specified condition of maturity from regeneration to final harvest.

**SELECTION CUT:** The removal of the mature timber, usually the oldest or largest trees either as single, scattered individuals or in small groups at relatively short intervals repeated indefinitely. The continuous establishment of unevenaged reproduction is encouraged.

**SHELTERWOOD CUT:** The removal of the mature timber in a series of cuttings which extend over a relatively short portion of the rotation. The establishment of evenaged reproduction is encouraged under the partial shade of seed trees.

**SITE CAPABILITY:** An expression of a particular area's ability to support forest growth. The better capability, the greater the rate of height and growth volume.

**SITE PREPARATION (SCARIFICATION):** An operation to expose mineral soil, mix mineral soil with humus, reduce competition from plants, and compact logging slash to make planting easier and generally improve the site in which the individual trees are to be planted or seeded.

**SOIL DEPTH:** The depth of a soil between surface and bedrock.

**SOIL DRAINAGE:** The rate at which water moves through the soil. Water moves quickly through well drained soils such as course sands and slowly through poorer drained soils such as clay.

**SOIL FERTILITY:** The amount and availability of nutrients contained in the soil necessary for plant growth. Fertility is directly dependent on the parent rock material; shale-derived soil is more fertile than granite-derived soil.

**SOIL STRUCTURE:** The degree of organization and arrangement of soil particles.

**SOIL TEXTURE:** The relative proportions of different sized particles that make up the soil complex.

**SPECIES:** A category of individuals thought of as a group because of common qualities and characteristics.

**STAND:** A group of trees, with similarities in species composition, height/diameter distribution, and age composition.

**STAND STRUCTURE:** The distribution of tree species and their age, height, species composition, diameter, and density of a specific area.

**STOCKING:** A relative term usually expressed as a percentage which refers to the number of trees that occur in a given area. An area that supports sufficient trees to optimally use all the available growing space is said to be 100% stocked. An area where only half of the available growing space is occupied by trees is said to be 50% stocked.

**SUPPRESSED:** Overtopped trees below general level of the canopy receiving no light either from the sides or above.

**SUSTAINED YIELD:** An objective of continuous production by an approximate balance between harvest and net growth.

**TAP ROOT:** A deep root system growing down into the ground which helps anchor the tree and maintain a water supply in dry soils.

**TOLERANCE:** The ability of a tree to regenerate and maintain health and vigour under shaded conditions. Very tolerant tree species can grow in dense shade.

**UNEVENAGED STAND:** A stand of trees with considerable age differences representing at least three age classes. Unevenaged stands contain large, older trees as well as immature trees.

**WINDTHROW:** Tree(s) uprooted by wind, commonly called blowdown.

## ANSWERS TO QUIZ QUESTIONS

**Lesson 1:**

1. False
2. True
3. False
4. False
5. True
6. False
7. True
8. True
9. False
10. False

**Lesson 2:**

1. False
2. False
3. True
4. True
5. False
6. False
7. False
8. True
9. True
10. True

**Lesson 3:**

1. True
2. False
3. True
4. True
5. False
6. False
7. True
8. False
9. True
10. False

**Lesson 4:**

1. True
2. False
3. False
4. True
5. False
6. True
7. True
8. True
9. False
10. False